dependence of crops and of live stock and its fluctuating financial equilibrium. Nor have Ville's formulæ for compound manures survived. The amount of food a plant requires is known to be modified by the water supply, the temperature, and the general soil conditions. It is clear that no one formula could possibly suit all cases; indeed, we might sum up the difference between Ville's views and those current now by saying that Ville regarded the supply of plant food as the dominating factor in determining fertility, whereas we now know it is only one of several equally important factors.

The lectures are interesting to read and must have been delightful to hear; they will form valuable material for the historian of agricultural science when he arises, not only by reason of the views set forth, but also because of the numerous balance-sheets and statements of costs. For their historical interest also they will be read by the serious student of agricultural chemistry, who indeed is already attracted to them by the fact that they have interested Sir William Crookes.

Certain alterations have been made in the text, so that the lectures are not quite in their original form. The editors have preferred to do this rather than to make corrections in footnotes, a plan which, if more cumbersome, would have had the advantage of preserving the historical value of the book. A chapter has also been added on the fixation of atmospheric nitrogen. All fixation methods attract much popular attention, while the electrical method first indicated by Sir William Crookes is already a rich and promising addition to our agricultural resources.

E. J. RUSSELL.

MODERN CHEMISTRY.

Handbuch der anorganischen Chemie. Herausgegeben von Dr. R. Abegg und Dr. F. Auerbach. Dritter Band, Zweite Abteilung. Pp. xii+921. (Leipzig: S. Hirzel, 1909.)

THIS stately volume of more than 900 pages treats of the elements of the fourth group of the periodic system, namely, C, Si, Ti, Ge, Zr, Sn, Pb, and Th. It opens with an excellent comparative summary by Abegg and Brauner of the general chemical and electrochemical relationships of the members of the group. Then comes a truly magnificent monograph on carbon by Weigert, covering 276 pages, with a literature-index containing 1307 references. It would be quite impossible in a short notice such as the present to give any adequate idea of the masterly manner in which the author has dealt with his great subject, so that a few references must suffice. In dealing with the allotropic forms of carbon, the usual purely descriptive account is followed by an extraordinarily interesting discussion of the energy- and stability-relationships, in which the researches of Schenck and Heller, and of Smits, are dealt with. The author also applies Nernst's theorem to the problem of the transition-point between diamond and graphite, but an arithmetical error appears to have crept into his calculation here.

The highly important theoretical and experimental researches on the formation, dissociation, and stability-relationships of the hydrocarbons are treated very fully, Nernst's thermodynamical theorem serving here (as elsewhere) as a basis for calculation. A good account is also given of Bone's work on the oxidation of hydrocarbons.

Under the heading of "Flame" the author does not fail to give us a lucid account of the modern work of Haber and his collaborators, whilst the subject of explosions introduces the reader to the work of Mallard and Le Chatelier and Dixon.

The chemistry of carbon has afforded the author a splendid opportunity of familiarising the chemist with the thermodynamics of high-temperature gas equilibria, and he has taken good advantage of it. The treatment of such highly important subjects as the dissociation of CO_2, the $C—CO_2—CO$ equilibrium, the water-gas equilibrium, and various heterogeneous gas-equilibria, such as $C—N—C_2N_2$, $C—S—CS_2$, $C—NH_3—HCN—H$, is excellent. The treatment of these matters brings the author to the discussion of such fundamental questions as the free energy of carbon combustion and the quantitative measure of the reducing power of carbon and its simpler gaseous compounds. What a vista is opened here to those who have the eyes to see and the minds to understand! It is a painful reflection to realise how soon all this will be as familiar to the trained modern German chemist as the laws of Dalton and Avogadro, whilst the progress of scientific chemistry in this country is still retarded by the false prophets who are affrighted by the sight of an algebraical symbol, and grievously lament the advance of physical chemistry.

There is an excellent and suggestive account of photochemical plant synthesis, and of the free-energy changes involved in biological metabolisms.

The heterogeneous equilibria presented by solid CO_2 in its various forms, and the ionic dissociation of aqueous solutions of carbonic acid, are well treated. More technical questions, such as the manufacture of coal gas, the calorific power of fuels, and the light efficiency of burning oils, come in for their share of discussion.

Enough has been said to give some idea of the scope and method of this splendid monograph. It is to be sincerely hoped that English chemists will carefully study it.

The next article (by Grossmann) deals with silicon and its compounds, and is full of interesting things. As befits the theme, a very full account is given of SiO_2, the silicic acids, and the silicates. Here we find an excellent *résumé* of Tschermak's interesting researches on the constitution of the silicates, together with the criticisms of Jordis, van Bemmelen, and Mügge thereon.

Another very interesting section deals with the work of Vogt, Doelter, and Allen and Day on the silicate melts.

Silicon is followed by a compact and up-to-date article of twenty pages on glass, by Schaller.

Titanium is dealt with by Jacoby. Here we find a very full discussion of the important work of Diethelm and Foerster on the electrochemical reduction of acid titanic sulphate solutions.

Germanium and zirconium are well presented by

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G. Rudorf and R. J. Meyer respectively, after which comes, if we may so express it, another *pièce de résistance* in the shape of a splendid article on tin from the pen of Ernst Cohen. In this is to be found a very scholarly and learned essay on the early history of this metal, and an exhaustive and beautifully illustrated account of that romantic and fascinating subject, the allotropic forms of metallic tin. As is well known, the chemistry of tin owes much to the researches of Cohen, and we are not disappointed in expecting to find his treatment of the subject exceptionally full and interesting.

Tin is followed by a long monograph on lead, by Ahrens and Pick. Here again the reviewer feels it his pleasant duty to bestow unstinted praise. The article opens with a very full account of the metallurgy of lead. The fundamental researches of Schenck and Rassbach on the heterogeneous equilibria between PbS, $PbSO_4$, PbO, and SO_2, are dealt with, however, under PbS. The electrochemical relations between lead and its ions are clearly and fully explained, including the work of Cumming on the oxidation-potentials of PbO_2. The chemistry of lead and its compounds offers many interesting points, all of which afford the author good opportunities for demonstrating the power and scope of physico-chemical methods of attack. Amongst these may be mentioned the work of Pleissner and Auerbach on the basic sulphates and carbonates of lead, the work of Pleissner and Auerbach and of Dolezalek on the solubility of $PbSO_4$ in water and sulphuric acid solutions, the work of Lewis on the solubility of $Pb(NO_3)_2$ in solutions of KNO_3 and $NaNO_3$, the stabilities and mutual relations of the oxides of lead, &c. In connection with the latter subject, the author has, however, missed the work of Brislee on Pb_2O.

In dealing with the demonstration by Allmand and Denham of the existence of *monovalent* lead ions, the author suggests by way of criticism that the experiments alluded to could be explained in another way, *i.e.* by the assumption of the existence of complex kations of the formula $Pb_2^{\cdot\cdot}$. These might still be *monovalent* ions, and the assumption by Allmand and Denham of the simpler formula $Pb^{\cdot}$ remains the best explanation until the existence of such complex kations is experimentally demonstrated.

After lead comes an article on the lead accumulator, by Mugdan. Needless to say, the article is chiefly concerned with the thermodynamic theory as worked out so beautifully by Dolezalek, although due mention is made of the early work of Faure, Planté, Gladstone and Tribe, and Streintz. This excellent article may be earnestly commended to the attention of electrical engineers. The usual English treatises on the lead accumulator consist of constructive details plus a little perfectly useless juggling with chemical symbols.

Thorium, the last member of the series, is dealt with by R. J. Meyer. Here is to be found an excellent account of the manufacture and optical (selective radiation) theory of the incandescent gas mantle.

Throughout the book colloidal states of matter are treated by Lottermoser. Of especial interest are the articles dealing with those classical examples, silicic and stannic acids.

Atomic weights are dealt with by Brauner in masterly fashion.

On laying down this wonderful volume, one cannot help feeling, as in the case of its predecessors, that Abegg's great undertaking marks the beginning of an era, the era of scientific inorganic chemistry. One realises with a spirit of rejoicing that inorganic chemistry has become a rational science of which every chemist may justly feel proud. The day of the why and the wherefore has dawned. One may beg leave to reason in inorganic chemistry as in other exact sciences. What middle-aged chemist of the present day can forget the inorganic chemistry of his youth, with its alchemistic recipes, its dry lists of formulæ, and its grim determination to explain *actions* by means of symbols invented to describe the *static* facts of composition? It was in truth little more than a sort of glorified black magic. Even at the present day there are not wanting signs that this sort of thing is not entirely dead. How many of our young graduates could read and thoroughly understand the pages of Abegg's "Handbuch"? One would not like to hazard an answer to that question, and yet on that answer depends very largely the hope of future progress. The methods of physical chemistry have converted the empiricism of the older inorganic chemistry into the rational science of to-day. The same tremendous transformation is fast approaching in the sphere of organic chemistry. Other things being equal, the victory lies with those who can best command the keen-edged weapons of physics and mathematics.

F. G. D.

TWO MAMMAL BOOKS.

(1) *The Grizzly Bear: the Narrative of a Hunter Naturalist, Historical, Scientific, and Adventurous.* By W. H. Wright. Pp. x+274; illustrated. (London: T. W. Laurie, 1909.) Price 7*s.* 6*d.* net.

(2) *The Animals and their Story.* By W. P. Westell. Pp. 322; illustrated. (London: R. Culley, n.d.) Price 5*s.* net.

(1) A VERY cordial welcome should be extended to Mr. Wright's intensely interesting volume, which has an exceptional value as embodying the experiences and opinions of a man who has hunted the great bear of the Rocky Mountains at a time when it was more numerous than is at present the case. The author tells us that he was born in New Hampshire in 1856, and that some time after 1883 he commenced bear-hunting during such intervals as could be spared from his business. Later on, in 1889, hunting became his profession, and he was seldom long away from the woods, his trips being sometimes made alone, but more frequently with companions who desired to be initiated into the mysteries of bear-stalking, and were able and willing to pay for the privilege.

"In the beginning," he writes, "I studied the grizzly in order to hunt him. I marked his haunts and his habits, I took notice of his likes and dislikes. . . . And then at last my interest in my opponent grew to overshadow my interest in the game. . . . I came to hunt him in order to study him. I laid aside my rifle. It is twelve years since I have killed a grizzly. Yet in all those years there is not

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